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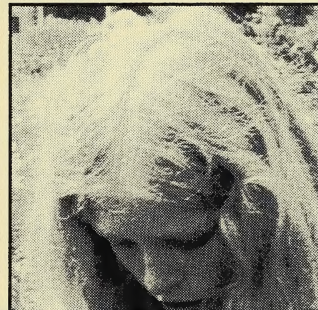
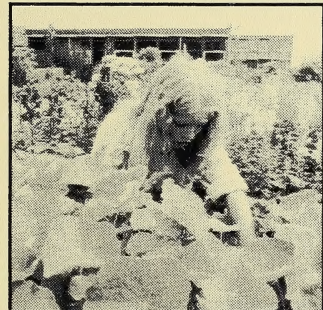
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# SCIENCE 14

## MODULE 7: ENVIRONMENTAL EXPLORATIONS

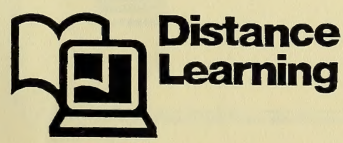
MODULE 7: ENVIRONMENTAL EXPLORATIONS

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## Learning Facilitator's Manual







# **Science 14**

## **Module 7**

# **LEARNING FACILITATOR'S MANUAL**



**Distance  
Learning**

**Alberta**  
EDUCATION



## Note

This Science Learning Facilitator's Manual contains answers to teacher-assessed assignments; therefore, it should be kept secure by the teacher. Students should not have access to these assignments until they are assigned in a supervised situation. The answers should be stored securely by the teacher at all times.

Science 14  
Learning Facilitator's Manual  
Module 7  
Environmental Explorations  
Alberta Distance Learning Centre  
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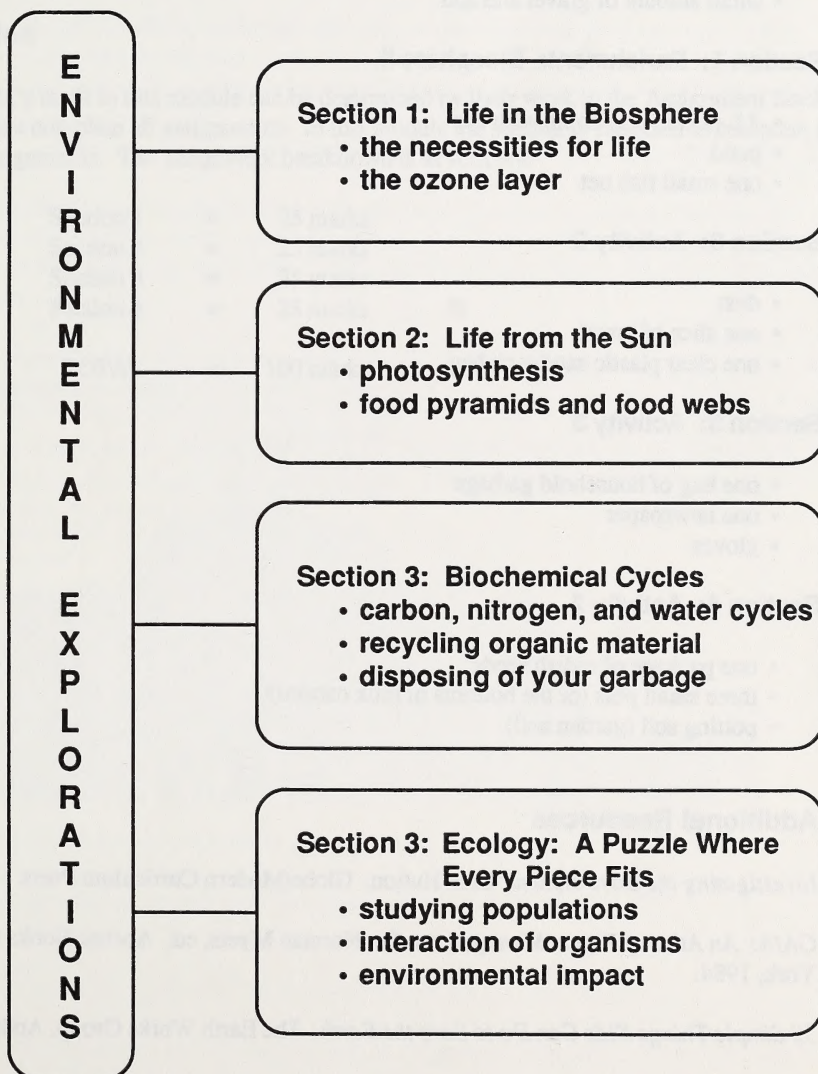
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## Module 7 – Environmental Explorations: Overview

The purpose of this module is to have the student become more aware of the environment. The student will identify the components of the biosphere that are essential to life. These components are investigated in detail, with emphasis on solar energy, recycling processes, and the interaction of organisms. The student will perform some hands-on investigations and research in order to develop a healthy concept of the biosphere, its components, and where humans fit in. The student should become more literate with respect to the environment and the effects on the environment due to human activity.





## Materials You Need

The following is a list of materials necessary to complete the investigations in Module 7. All materials are common items which are found in most households or are available at low cost from most stores.

### Section 1: Enrichment: Biosphere I

- one large wide mouth jar
- one healthy houseplant small enough to fit into the jar
- small amount of gravel and soil

### Section 1: Enrichment: Biosphere II

- 2 L plastic pop bottle with cap
- pond
- one small fish net

### Section 3: Activity 2

- dust
- one slice of bread
- one clear plastic sandwich bag

### Section 3: Activity 3

- one bag of household garbage
- one newspaper
- gloves

### Section 4: Activity 2

- one package of radish seeds
- three small pots (or the bottoms of milk cartons)
- potting soil (garden soil)

## Additional Resources

*Investigating the Environment* Glen Hutton. Globe/Modern Curriculum Press.

*GAIA: An Atlas of Planet Management* Dr. Norman Myers, ed. Anchor Books Garden City, New York, 1984.

*50 Simple Things Kids Can Do to Save the Earth.* The Earth Works Group, Andrews & McNeil.

*Living in the Environment*, 6th Edition G. Tyler Miller Jr. Wadsworth Publishing Corporation, Belmont, California 1990.

## Possible Media

- TV series *The Nature of Things*
- There are a large variety of shows on PBS and ACCESS Network relating to the module.

## Evaluation

The student's mark in this module can be determined by their work in the Assignment Booklet. Each student must complete all assignments. In this module the student is expected to complete four section assignments. The assignment breakdown is as follows:

Section 1	=	25 marks
Section 2	=	25 marks
Section 3	=	25 marks
Section 4	=	25 marks

TOTAL	=	100 marks
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## Section 1: Life in the Biosphere

This section focuses upon the thinness of the biosphere. Normal approaches tend to make the biosphere seem very thick. In reality, the majority of life in the biosphere is found in a very thin layer. It is then easier to comprehend the fragility of the life zones on Earth. The student should have a solid concept of the fundamental components of the biosphere that are essential to life on the earth.

### Section 1: Activity 1

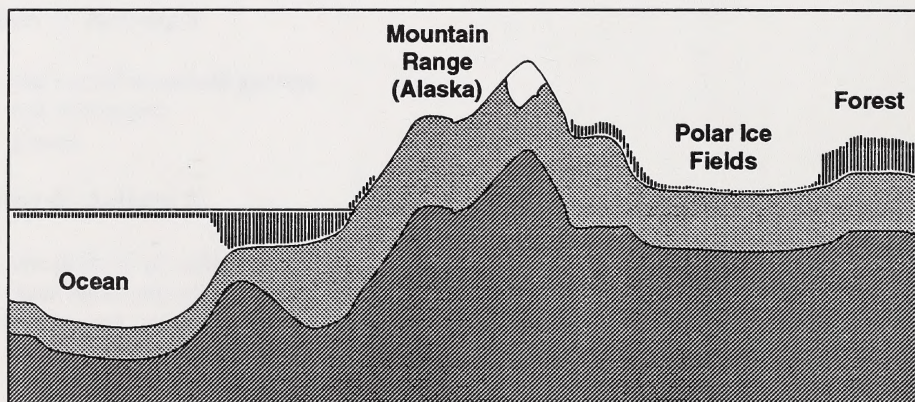
1. Explain the meaning of the term *biosphere* in your own words.

*The biosphere is the thin layer where life exists on Earth. The thickness of the biosphere varies over different geographical areas and structures (mountains, rainforests, oceans, and so on).*

2. Why is there much less life found at depths below 180 m in the oceans?

*Almost all life depends on the producers. Since sunlight cannot penetrate more than 180 m in water, photosynthesis cannot occur, resulting in no producers being present below this depth. If there are no producers, then the variety of life is limited.*

3. Use lines to show the thickness of the life zones in the areas described by the following diagram.





## Section 1: Activity 2

### Investigation: Necessities of Life I

1. In which jar did the flies live the longest? Why?

*The flies probably lived the longest in the jar with the water. While food is necessary for life, water is even more essential since animals can live on stored food (fat). Most organisms cannot store water in their bodies.*

2. In which jar did the flies die first? Why?

*The flies in the jar with nothing in it probably died first. These flies lacked both water and food, two of the necessities for life.*

3. Why did the flies in the water jar die very quickly?

*The flies drowned in the water. Flies get their oxygen from the air and cannot get oxygen from the water.*

4. Why did the flies in the food jar also die quickly?

*Flies need food, water, and air. Since the jar was filled with food, not very much air was provided and certainly no water was provided. The flies would quickly use up the small amount of oxygen in the jar and die.*

5. Jimmy noticed that the flies in both jars were all doing quite well. Do you think that light makes a difference to the life of a fly? Explain your answer.

*Two weeks without light does not make much of a difference to a fly. Flies are able to detect food and water by using their senses of smell, touch, and taste. Light is only required by the producers.*

6. Which jars had flies living in them after one day?

*The jars labelled warm and cold should have had live flies after one day.*

7. Why did the jar in the freezer not have any live flies ?

*Flies cannot generate enough body heat to keep warm in a freezer. They would have been frozen.*

8. Based on your observations from step D, how do you think flies survive the Canadian winter?

*Flies, like many insects, produce special chemicals which prevent ice crystals from forming in their bodies. Given time to prepare and given a sheltered place that is protected from wind, sun, and snow, the insects can survive the winter in a dormant state.*

9. Based on your observations from Jimmy Flypaper's experiment with flies, list the main things that most animals need to live.

*The main things that animals need to live are air, suitable temperatures, water, and food.*

10. Can you think of any other things that are absolutely necessary for animals to live?

*Animals must also have protection from predators, disease, parasites, and harmful radiation from the sun. The air, food, and water must be free of poisonous pollutants.*

### Investigation: Necessities of Life II

11. In which bag did the seedlings live longest? Explain your answer.

*The seedlings in the bag with water only should have lived the longest. Water prevented the seedlings from drying out, allowing them to carry out essential life processes such as photosynthesis.*

12. In which bag did the seedlings die first? Explain your answer.

*The seedlings in the dry soil probably died first because the soil absorbed all the available moisture from the seedlings. The seedlings in the bag with air only would not have survived very long either. You may have predicted that the plants in air only would die first since water is a very important element for plant life.*

13. Why did the seedlings in the bag containing soil and air die very quickly?

*The soil must have been very dry, absorbing all the available moisture from the seedlings.*

14. Would the seedlings in the bag containing water and air die very quickly?

*No, the seedlings would continue to live in the bag with water and air for at least a week. The water and air allowed the seedlings to carry out most essential life processes.*



15. Why were the seedlings in the bag containing soil and water (but no air) still alive after 3 weeks?

*There is a lot of air trapped in soil. Seedlings can recycle the air as long as they receive sunlight for photosynthesis. The moist soil and air provided the seedlings with an ideal environment for growth.*

16. Josie noted that the seedlings that were kept in the sunlight were doing quite well. The seedlings that were kept in the dark were pale yellow and very spindly. Do you think that light makes a difference to plant life? Explain your answer.

*Light is critical to plant life. Plants use light to produce the food that they need to grow and repair their cells. Without light, plants cannot survive.*

17. Which bags had live seedlings after 2 days?

*The bags labelled warm and cold should have had live seedlings after 2 days. The seedlings would not have survived freezing temperatures.*

18. Why did the seedlings in the freezer die?

*Freezing temperatures will kill radish seedlings. They have no means of preventing the damage done when water in their cells freezes and breaks the cells open.*

19. How do plants survive the Canadian winter?

*This is an area still under considerable research. Apparently some plants such as trees and shrubs, have a mechanism which produces special substances that prevent ice crystals from forming and rupturing the plant cells. You may want to research this topic further.*

20. Based on your observations, list the main things that plants need to live. List them in order of importance – most important first.

*Plants need air, proper temperatures, water, sunlight, and nutrients from the soil. You might have listed some other things such as protection from predators and disease. Your list may have varied somewhat in order of importance because it can be argued that one element is more important than another in certain situations.*

21. Can you think of any other things that are absolutely necessary for plants to live?

*Some plants require insects, mammals or birds to reproduce. Plants also need a variety of trace elements in the soil. You should be aware that some of the seemingly minor things that are often overlooked are actually necessary for plant life. If an element such as zinc or magnesium is missing or in short supply, the plants may continue to grow, even for a few generations, but their growth would not be ideal. These plants might be stunted, deformed, or unable to produce healthy seed.*

### Section 1: Activity 3

1. What is ozone?

*Ozone is a form of oxygen. Each molecule contains three oxygen atoms. Ozone is actually a poisonous gas if you breathe it, but it is very important in the upper atmosphere since it shields the earth from ultraviolet light.*

2. What effects does ultraviolet light have on human skin?

*Ultraviolet light of the longer wavelengths causes skin to tan. The shorter wavelengths of ultraviolet light cause skin to burn. Increased exposure to ultraviolet light causes an increase in the occurrence of skin cancer.*

3. What substances in the ozone layer protect life on Earth from ultraviolet light?

*Oxygen and ozone in the ozone layer protect life from ultraviolet light.*

4. CFCs are chemicals that have come under strong criticism because they destroy the ozone layer. What does CFC stand for? What are these chemicals used for?

*CFC is the abbreviation for chlorofluorocarbon. CFCs are used mainly as refrigerants in air conditioners and other cooling devices such as freezers and fridges. CFCs are also used to produce foam cushions, plastic foam products, and are used as propellants in spray cans.*



## Section 1: Follow-up Activities

### Extra Help

Use the words from the list to complete the sentences.

air	ocean
atmosphere	oxygen
biosphere	ozone
cancer	ozone layer
cataracts	protection
CFCs	radiate
coastal	rain forest
desert	sphere
food	sunlight
global warming	temperatures
grasslands	ultraviolet radiation
land	water

1. The sun and the planets all have the shape of a *sphere*.
2. All life on the planet Earth is found in a layer called the *biosphere*.
3. The *ocean* covers about 76 percent of the earth.
4. The thickest layer of life on land is found in the *rain forest*.
5. One of the thinner layers of life on land is found in the *desert*.
6. The *grasslands* make up a layer of life on land that is of intermediate thickness.
7. The three zones of the biosphere are *water*, *land*, and *air*.
8. The majority of the fishing done by man occurs in the *coastal* regions.
9. *Sunlight* can only penetrate to a maximum depth of about 180 m under water.
10. All living things need *food* to produce energy and to grow.
11. The layer of air surrounding the earth is called the *atmosphere*.
12. Plants and animals can only live within a small range of *temperatures*. If this range gets too high or too low, the organism will burn or freeze.
13. All living things need *protection* from predators.

14. *Oxygen* molecules are split in the first step of ozone production.
15. The *ozone layer* protects the earth from dangerous ultraviolet radiation.
16.  $O_3$  is the chemical symbol for *ozone*.
17. The sun will continue to *radiate* energy for many millions of years.
18. When you get a sunburn on a cloudy day, you have been burned by *ultraviolet radiation*.
19. The ozone layer absorbs harmful radiation which is known to cause skin *cancer*.
20. Exposure to ultraviolet radiation can cause *cataracts* in the eyes.
21. The earth's increase in temperature due to the greenhouse effect is called *global warming*.
22. Chemicals used in refrigerators and air conditioning systems are called *CFCs*, the abbreviation for chlorofluorocarbons.

### Enrichment

You have been exposed to a variety of living systems such as house plants, aquariums, house pets, and maybe ant farms, to name a few. All of these require extensive feeding, watering, and cleaning. What would happen if you did not perform all the chores that pets and plants require? Right. They would not survive. Try **either** Part A or Part B, and you will discover something of interest. Then go on to complete Part C.

### Part A: Biosphere I

Into the clean jar place a layer of gravel. Cover the gravel with a layer of soil. Plant the houseplant in the soil. Add enough water so that you can just see some water in the gravel, but be sure not to flood the soil. Seal the jar with plastic wrap and screw the lid onto the jar. Leave the jar in a place where it will get a reasonable amount of sunlight for the plant. How long do you think the plant will survive? Write a summary of your activity and try to explain why a plant can live so long in a sealed jar. If you do not have access to a small houseplant, you can plant some geranium seeds in the jar and then seal it. Simply ensure that there is enough water in the gravel before you seal the jar.

*A plant (or a group of plants) sealed in a glass or plastic container is called a terrarium. The plant(s) will recycle oxygen, carbon dioxide, and water as long as sunlight is provided. The same concepts are being studied as solutions to problems with recycling air and water during long distance space travel.*



## Part B: Biosphere II

Take a 2 L pop bottle and fill it with pond water. Include some of the weedy floating plants that you find in the water. Catch some small pond creatures, such as snails and bugs, and put them into the bottle as well. Seal the bottle and leave it in a place where it will receive sunlight. Observe this system for as long as you wish. Write a summary explaining why life in a sealed container can continue for such a long time.

*This is a sealed aquarium. The plant life will produce oxygen and food for the animals in the container. You will probably notice that the larger creatures will not survive indefinitely, but some life forms can survive and reproduce in this sealed aquarium for incredibly long periods of time.*

## Part C: Biosphere III

This activity requires a good imagination. Imagine that you are put in charge of obtaining all of the materials required for a ten-year space mission for ten astronauts, yourself included. You will not be able to get any other supplies on the way, nor will you be able to return to planet Earth if you forget something. Make a list of all the things and their quantities that you and the crew will need on the ten-year trip.

**Note:** There is no suspended animation possible yet for humans, so you will have to have enough water, air, and food for daily activities.

*You will need vast amounts of food, water, and air to last for ten years. Each person needs about 1 kg of food, 2.5 L or 2.5 kg of water, and about 1 kg of oxygen per day. In a ten-year trip there are 3650 days (365 days per year  $\times$  10 years). Multiply the amount of material needed each day by the total number of days.*

$$\begin{aligned} & \frac{(2.5 \text{ kg} + 1 \text{ kg} + 1 \text{ kg})}{\text{day}} \times 3650 \text{ days} \\ &= \frac{4.5 \text{ kg}}{\text{day}} \times 3650 \text{ days} \\ &= 16\,425 \text{ kg} \end{aligned}$$

*By the calculations you will need to send 16 425 kg per astronaut. Thus, for a crew of ten you will need 164 250 kg (16 425 kg  $\times$  10) of food, water, and air. This, of course, does not include many essentials such as clothing, water for washing, toiletries, and so on. Obviously, a recycling program of some kind is required for the water, air, and even for the food.*

## Section 2: Life from the Sun

Energy from the sun is crucial to life on Earth. Solar energy is noncyclic – it provides energy without fail. This can be a difficult concept to comprehend because the sun is taken for granted. The recycling of carbon, oxygen, and water is introduced. Invite students to discuss this concept in depth and possibly do some research on their own to determine the amount of solar energy the earth receives. Ensure that students understand that organisms that fix solar energy through photosynthesis are the foundation of the food chain. Stimulate discussion to bring this section alive. You might also want to demonstrate the sealed aquarium to show how the system will continue to live as long as solar energy is provided.

### Section 2: Activity 1

1. What three main components do plants need to produce food?

*Plants need sunlight, carbon dioxide, and water to produce food.*

2. The process by which plants produce food is called *photosynthesis*.

3. Why do plants make food?

*Plants make food to carry out the processes of growth, reproduction, and the repair of cells.*

4. Why don't animals make their own food?

*Animals cannot make their own food because they lack chlorophyll, the pigment which allows plants to carry out photosynthesis.*

5. Organisms which produce their own food through photosynthesis are *plants*.

6. The microscopic plants abundant in the oceans are *phytoplankton*.

7. Organisms that produce their own food also produce a waste gas called *oxygen*.

8. What is respiration?

*Respiration is the process whereby food and oxygen are combined in body cells to produce energy, carbon dioxide, and water.*



9. Plants cannot recycle *the sun's energy*.
10. Most of the energy that the earth receives from the sun is radiated as *heat energy*.

## Section 2: Activity 2

1. What is a producer?

*A producer is an organism capable of making its own food by photosynthesis.*

2. What is a consumer?

*A consumer is an animal that does not make its own food.*

3. What percent of the sun's radiation is actually absorbed by the earth?

*About 65 percent of the sun's radiation that reaches the earth is absorbed.*

4. What percent of the solar radiation that is absorbed by the earth is used by plants?

*Less than 2 percent of the solar radiation that is absorbed by the earth is used by plants.*

5. What percent of the solar radiation used by plants becomes food for consumers?

*About 10 percent of the solar radiation used by plants becomes food for consumers.*

6. Why do consumers need producers?

*Consumers need producers to produce the food energy that they need.*

7. Why do producers need consumers?

*Producers need consumers to complete the carbon cycle and to keep producer populations at reasonable levels.*

8. How is carbon recycled in the biosphere?

*Plants fix carbon in their bodies by converting carbon dioxide from the air into sugars.  
Animals and plants burn the carbon in sugars to produce energy and carbon dioxide.*

9. How is oxygen recycled in the biosphere?

*Plants release the oxygen from carbon dioxide in the production of food. Plants and animals use the oxygen to burn their food. This process produces carbon dioxide.*

10. It seems that everything on the earth is recycled. Why is it not important for the energy from the sun to be recycled?

*The sun is a continuous source of solar energy. In general, the earth radiates as much energy as it receives. All things on the earth are fixed in quantity, and so they must be recycled. Solar energy is not fixed; the supply is continuous. Thus, it does not need to be recycled.*

11. Explain what would happen if there were no consumers, only producers, on the earth?

*The carbon cycle would be broken. There would be less and less carbon dioxide available to plants (producers). The producer populations would decrease. Another effect would be the incredible fires fuelled by the large masses of plant matter and high concentrations of oxygen in the atmosphere.*

### Section 2: Activity 3

1. List at least five producers found in your area.

*Your list should contain the names of various plants like trees and grasses, algae, and possibly phytoplankton.*

2. List at least five first level consumers found in your area.

*Your list should contain the names of various plant-eating animals. Examples could include animals such as cattle, horses, sheep, deer, and beaver.*

3. List at least five second level consumers found in your area.

*Your list should contain the names of various carnivores such as frogs, coyotes, cats, or people.*

4. List as many third level consumers found in your area as you can.

*Your list should include snakes, hawks, bears, fish, and any other third level consumers that you can think of.*



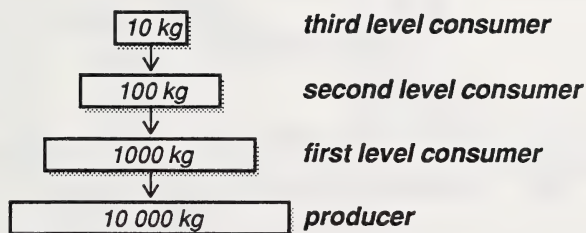
5. Explain the meaning of the rule of ten.

*Each level of consumers stores about 10 percent of the energy from the level which it consumes.*

6. What percent of the energy of a second level consumer is not passed on to the third level, but instead is given off as heat, or used for movement?

*About 90 percent of the energy of the second level is not stored in the third level.*

7. Suppose you are studying the food pyramid in a particular meadow. You measure all of the third level consumers in the meadow and find the weight to be a total of 10 kg. Assume that the rule of ten applies to weight. Trace backwards through the food pyramid to find the total weight of the plant material that you would find in the meadow.

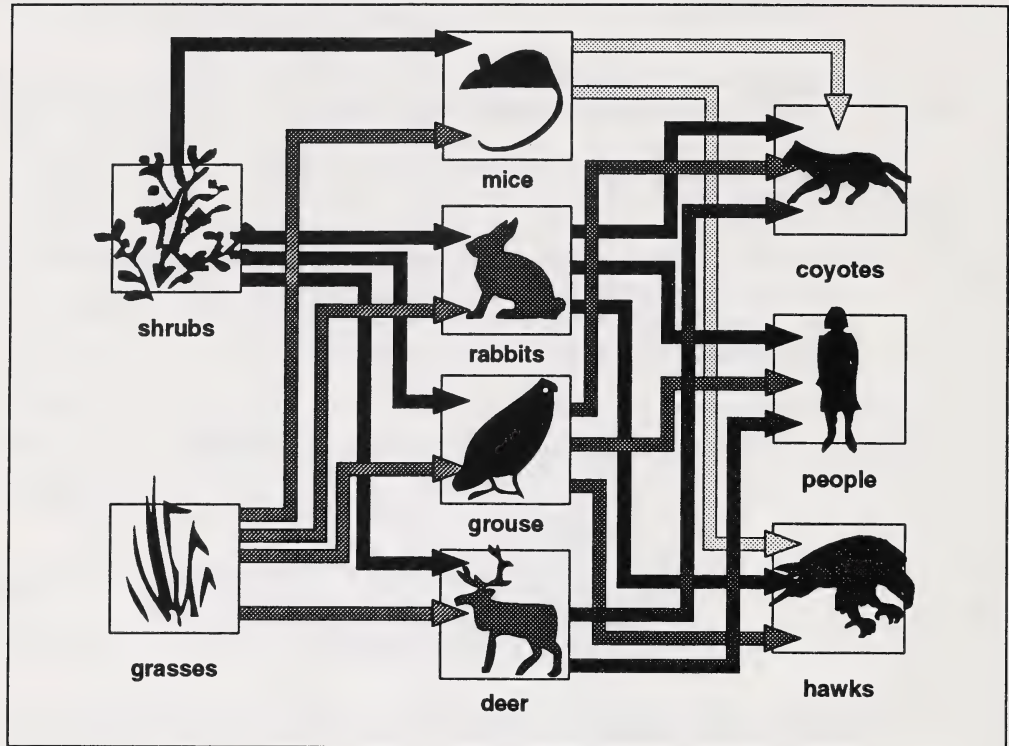


*The amount of plant material in the meadow should be about 10 000 kg.*

8. Decomposers can cause problems for people. List the ways in which decomposers cause problems.

*Decomposers usually present themselves as a problem when they spoil food. Decomposers are also at work decomposing the wood, furniture, carpets, and many other things in your home. There are even decomposers which attack iron, plastic, and oil. Decomposers can also cause health problems such as allergies.*

9. Construct a food web using the following plants and animals: grasses, shrubs, deer, grouse, rabbits, coyotes, mice, hawks, and people.



10. Suppose you read a newspaper article in which the author argues that all organisms that spoil food should be destroyed. Write a letter to the editor explaining why this idea is unreasonable.

*Your letter should point out the role of decomposers in the recycling of essential elements in the biosphere. You should be specific and convincing in your arguments. You might discuss the carbon and oxygen cycles. You should probably also discuss decomposers as an important source of food for many organisms. Therefore, getting rid of decomposers will solve the food spoilage problem, but a much larger disaster will replace it when the biosphere becomes unbalanced.*



## Section 2: Follow-up Activities

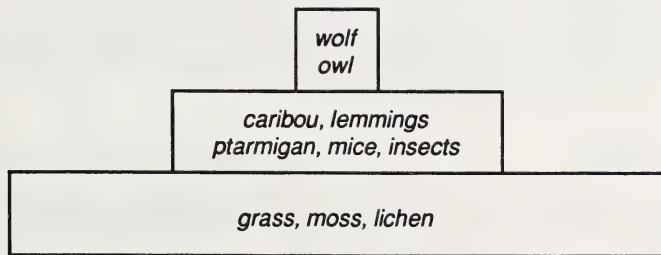
### Extra Help

1. a. Photosynthesis is the process by which plants convert *energy (radiation)* from the sun into *food energy*.
  - b. Photosynthesis requires three raw materials: *carbon dioxide, water, and light energy*.
  - c. Most of the energy in any level of a food pyramid is lost as *heat*.
  - d. A *food web* is a better description than a food pyramid.
  - e. *Decomposers* are organisms which break down dead plants and animals into very simple chemicals.
  - f. Only *10 percent* of the energy of a consumer level is stored by the next consumer level.
  - g. Photosynthesis produces *food and oxygen*.

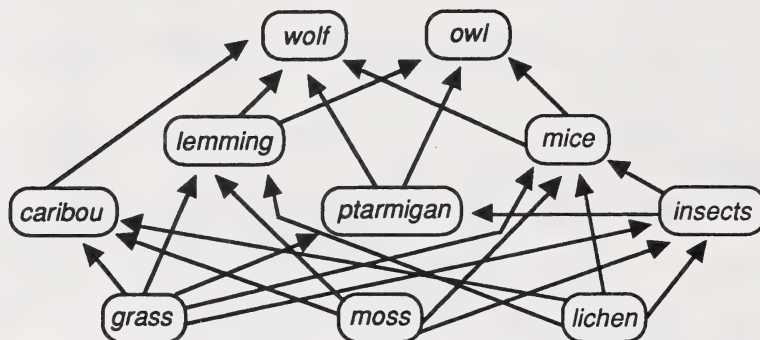
2. If living things could reuse the sun's energy, the sun could stop shining and life on Earth would continue. Explain why the sun's energy cannot be reused by living things.

*All living organisms convert food into heat energy that is used for various life functions. All of the energy that is used is ultimately converted into infrared radiation (heat). This radiation escapes from the earth. Producers cannot use infrared radiation (heat) to produce food; thus the sun's energy is not recyclable.*

3. The following plants and animals are found in the northern tundra: caribou, lemmings, ptarmigan, field mice, wolves, owls, grass, moss, lichen, and plant-eating insects.
  - a. Use the plants and animals listed to draw a food pyramid of the northern tundra.



- b. Use the plants and animals listed to draw a food web of the northern tundra.



### Enrichment

Identify and make a list of plants and animals that are found in your local area. Use old magazines and papers to collect pictures of these plants and animals. Draw the pictures of those you cannot find. Obtain a piece of poster paper large enough to hold all of the pictures. Arrange the pictures so that you make a food web of your area which is easy to understand. Use coloured pens or crayons to draw the arrows that connect each food to the consumer of the food. Neatly label your food web. Put it up for display in your home and watch the interest and discussion it generates for your family and friends.

*This activity will vary according to your particular region. The interest and discussion it will generate depends on the effort that you put into your work.*

## Section 3: Biochemical Cycles

In contrast to Section 2, this section deals with total recycling. The concept of virtually 100% recycling is usually foreign to students since they expect natural recycling to be similar to the recycling methods used in modern society. This is an ideal time to stress biodegradable recycling and to focus on the poor waste programs that are currently being used. Encourage the student to search for new answers to the waste disposal problem.

### Section 3: Activity 1

1. When oxygen is used by plants and animals, what two things are released into the environment to be recycled?

*Carbon dioxide and water vapor are released when oxygen is used by plants and animals.*



2. When water and carbon dioxide are used by plants in photosynthesis, what element is released into the environment for recycling?

*Oxygen is released into the environment for recycling.*

3. Sometimes small amounts of carbon are removed from the carbon cycle. In what two forms is this carbon stored?

*Carbon is stored in fossil fuels and limestone.*

4. What organisms are most important in the recycling of oxygen. Explain your answer.

*Green plants are the major recyclers of oxygen. Plants use a process known as photosynthesis to make oxygen available to other organisms.*

5. What organisms are responsible for fixing free nitrogen from the air into nitrates?

*Bacteria and blue-green algae are responsible for fixing nitrogen into nitrates.*

6. How do plants obtain the nitrogen they need?

*Plants absorb nitrogen through the root system as nitrates dissolved in water.*

7. How do animals obtain the nitrogen they need?

*Animals get their nitrogen by eating organisms which have stored nitrogen in their bodies.*

8. Explain how plants and animals recycle water.

*Plants and animals produce water during respiration. Plants also use water in the production of food (sugars). Notice the difference in how plants and animals use water. Plants actually break the water down during photosynthesis. Animals use water in their living processes but do not break the water down. It remains as water throughout.*

9. Use your dictionary to define the word *reuse*.

*reuse: to use again for the same purpose*

10. What is the difference between *recycle* and *reuse*?

*Recycle means to reprocess something so that it can be used again, often for another purpose than what it was used for originally. Reuse means to use again for the same purpose as it was used originally. For example, writing paper can be recycled into a variety of paper products such as writing paper, cardboard, and so on. A cardboard box used to ship jars can be reused to store jars or anything else.*

11. What are the four main things that nature recycles?

*Nature recycles oxygen, carbon, nitrogen, and water.*

### Section 3: Activity 2

#### Investigation: Decomposers in Action

##### Observations

STEP A	
After 2 Days	<i>You might see some green or black areas on the bread. You may not see any difference.</i>
After 4 Days	<i>You will most likely see green or black spots on the bread slice.</i>
After 6 Days	<i>The coloured spots should have grown larger.</i>
After 8 Days	<i>The coloured spots have grown much larger and should be forming a thick mat.</i>



STEP B	
<b>After 16 Days</b>	<i>The slice of bread should be almost completely green or black in colour. The mat of growing material should be very thick.</i>

1. What is the common name of the substance that was growing on the bread slice?

*Bread mould is the common name for the substance.*

2. If you left the bread slice for a very long time, what do you think would be left of it?

*The bread slice would be completely decomposed if left long enough.*

3. Why are the decomposers so important to the recycling of elements?

*Decomposers are essential to break down the dead bodies of plants and animals that are not eaten by other organisms. This completes the cycle of all the important elements. Without decomposers the biosphere would soon run short of essential elements.*

4. What are the two main groups of decomposers?

*Fungi (moulds) and bacteria are the two main groups of decomposers.*

### Section 3: Activity 3

#### Investigation: Garbage!

1. List the biodegradable items that you found.

*This list will vary but should include items such as fruits, vegetables, table scraps, paper, and so on.*

2. List the nonbiodegradable items you found.

*This list will vary but should include items such as glass, metal cans, and plastics.*

3. In this one bag of garbage was there more biodegradable or nonbiodegradable garbage?

*This will vary, depending on the bag of garbage you used.*

4. What could you do with the biodegradable garbage?

*You could compost much of this garbage. Meats and dairy products should not be composted.*

5. What could you do with the nonbiodegradable garbage?

*Much of this garbage is recyclable. Find out which items are taken by your local recycling depot. Clean them as necessary, and do your part by recycling.*

6. What would you suggest that people do to reduce the amount of garbage they produce?

*You should suggest composting organic wastes and recycling inorganic wastes. You could also suggest not purchasing items that cannot be recycled or items that have excess packaging. You might be more specific depending on your location.*

7. List the ways that your community disposes of wastes. Be sure to include any recycling programs.

*Your answers will vary. You should be able to include some of the following:*

- *composting*
- *paper recycling*
- *plastic recycling*
- *metal recycling*
- *oil recycling*
- *glass recycling*

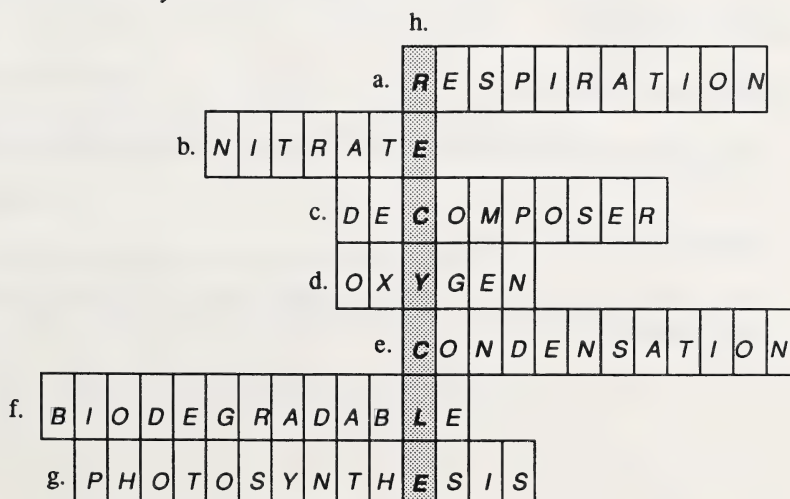
*The traditional forms of waste disposal are landfills and incineration.*

### Section 3: Follow-up Activities

#### Extra Help

1. The two living organisms which are the main recyclers of nitrogen are *bacteria* and *blue-green algae* because they fix free nitrogen into nitrates.

2. Plants and animals recycle three substances. These three substances are *carbon*, *oxygen*, and *water*.
3. The nonbiochemical recycling of water occurs by *evaporation* and *precipitation*.
4. Substances which cannot be broken down by living organisms are *nonbiodegradable*.
5. Substances which can be broken down by living organisms are *biodegradable*.
6. The main decomposers are *fungi* and *bacteria*.
7. The following acrostic puzzle will provide you with some added practice with the terminology found in this section. Place the term that is being defined in the appropriate row of the acrostic. Find the hidden word when all the other words are complete.
  - a. a process animals carry out to produce energy in which a by-product is carbon dioxide
  - b. the type of nitrogen-containing molecule that plant roots can absorb
  - c. a bacteria or fungi that recycles dead material
  - d. a by-product of photosynthesis
  - e. the process of water's changing from a vapour to a liquid or solid
  - f. organic material that can be broken down
  - g. the process by which plants make food
  - h. **Hidden Word** *recycle*





### Enrichment

1. Call your local waste department and list all of the ways they dispose of waste in your area.

*This list will vary. Some of the ways you might find are as follows:*

- landfill
- special storage for future recycling
- separation of recyclables for recycling
- hazardous wastes shipped to Swan Hills
- composting of biodegradables

2. Discuss the pros and cons of your local waste-management system and make environmentally sensible suggestions for the disposal and recycling of wastes.

*This answer will vary. The suggestions you make should be viable and sensible enough to make your waste-management system change for the better.*

### Section 4: Ecology: A Puzzle Where Every Piece Fits

This is an excellent place to discuss the reasons why the human population continues to expand exponentially, in contrast to the natural population limitations. You should continually focus on the limiting factors that work for all populations except humans. There are many opportunities to research the ecological problems that individuals, businesses, and governments cause and the reasons for allowing these disasters to continue. Have students find information on ecological topics – the library is full of them.

#### Section 4: Activity 1

1. Define the term *ecosystem*.

*The ecosystem is a part of the biosphere where living and nonliving things interact.*

2. Explain the term *physical factor*.

*A physical factor is any one of the things (usually nonliving) in an ecosystem with which living things interact.*

3. List all of the physical factors you can think of which limit population growth.

*This list should include food, water, air, sunlight, temperature, soil conditions, and any other factors you can think of.*

4. What are the physical factors that limit the gopher population in a prairie grassland ecosystem?

*Some of the factors which would limit a gopher population are the amount of food, water, number of predators, and the suitability of the soil conditions for digging dry burrows in which to live.*

5. What are the physical factors that limit the moose population in a northern pine forest ecosystem?

*Moose need particular kinds of food, such as willows and young poplar trees. The availability of these foods is essential. Moose also need small lakes and marshes, both to escape from insects and to feed on the lush vegetation. The forest must be a suitable place to raise young.*

6. The first step in the life of a plant is seed germination. This is when the seed sends out roots and leaves. Temperature, water, and light might be the physical factors which affect germination. Design an experiment which will study the effects of temperature, moisture, and light on seed germination. Be sure to include a list of materials and the steps you should follow. It is suggested that you use radish seeds or some other inexpensive seeds which germinate quickly.

*Your experiment should center on seeds which germinate quickly, such as radish or alfalfa. You should ensure that each factor is tested independently from the others. For example, you can test the effects of temperature on seed germination by placing seeds samples in the refrigerator, freezer and kitchen cupboard. Be sure and check that your procedure will test only one physical factor at a time.*

## Section 4: Activity 2

### Investigation: The Effects of Crowding on Plant Growth

#### Observations

**Day 1**    *The radish seeds are sprouting in all three containers.*

**Day 3**    *All three containers show the same type of growth for the seeds.*

**Day 5**    *The radish plants in the container with 100 seeds seem to be taller and more spindly than the ones in the containers with five and twenty seeds.*

- Day 7** *The plants in the container with 100 seeds are definitely taller than those in the containers with five and twenty seeds. The plants in the containers with five and twenty seeds seem to be about the same.*
- Day 10** *The plants in the pot with five seeds seem to be the healthiest. The plants in the pot with twenty seeds are taller and more spindly than those in the pot with five seeds. Some of the plants in the pot with 100 seeds are turning yellow. The other plants in the container can hardly hold themselves upright.*
- Day 14** *The plants in the container with five seeds are the shortest, greenest, and have the largest leaves. The plants in the container with twenty seeds are taller, less green, and have smaller leaves than those in the pot with five seeds. The plants in the container with 100 seeds are very tall and spindly, have a pale green or yellow colour, and have much smaller leaves than those plants in the containers with five and twenty seeds.*

1. In which pot or pots did you get the largest, healthiest plants? Why do you think this is so?

*The pot with five seeds produced the largest, healthiest plants. Note that these were not the tallest plants, but certainly the largest. These plants were not overcrowded, so they did not have to compete for water, sunlight, and soil nutrients, as did the plants in the pots where overcrowding was a factor.*

2. Based on your results from the first 14 days, which pot do you think will produce the best radishes? Explain why you answered as you did.

*The plants in the pot with five seeds will produce the best radishes. These plants are not overcrowded and will be able to produce the most food, which is then stored in the root of the radish. The other pots are overcrowded and there is just not enough water, sunlight, and soil nutrients to produce very good radishes.*

3. When plants are overcrowded, which physical factors are limited because too many plants are competing for them?

*Sunlight, water, and soil nutrients are limited.*



4. The purple loosestrife is native to Europe and Asia. There the population of this plant with pretty flowers is controlled by insects. The loosestrife was brought to North America by accident and has spread throughout Canada. The hardy plant grows to a height of 1 to 1.5 metres in the Canadian wetlands. Since the plant has no natural enemies here, and wildlife does not eat the plant, purple loosestrife has quickly spread across Canada. Explain the impact that the purple loosestrife will have on the inhabitants of a Canadian wetland.

*The purple loosestrife will replace the natural grasses and shrubs of the wetland. The organisms which depend on the natural grasses and shrubs for food will be forced to move or starve. The impact on the wetlands will be devastating and that is why biologists are very concerned about purple loosestrife in Canada.*

5. An elaborate system of locks was built to enable ships from the Atlantic Ocean to travel into the Great Lakes. How did this construction affect the populations of fish in the Great Lakes? Hints: The lamprey eel was able to invade the Great Lakes after the shipping lanes were built, and many foreign species of ocean life (such as the zebra mussels) have since been introduced into the Great Lakes through these shipping lanes.

*The locks allowed other species of organisms to enter the Great Lakes. Prior to the shipping lanes, new species could not move up the St. Lawrence River into the Great Lakes because of barriers such as large waterfalls. These new species are often predators, parasites, and nuisance species that are destroying the native species of fish. Therefore, the populations of native fish are decreasing.*

6. Zebra mussels were introduced into the Great Lakes in 1988 when a ship emptied its ballast water. The mussels have spread quickly and are now clogging intake pipes of water treatment stations, power plants, and irrigation systems. They are ruining fish spawning grounds and eating the food needed by native fish and other species. Explain the effect that the zebra mussel population will have on other Great Lakes populations in the near future.

*Zebra mussels will cause the populations of most other organisms to decrease. One reason is that zebra mussels consume the foods that other organisms use. Since very few organisms use zebra mussels for food, the balance established in the Great Lakes would be disrupted. When fish spawning grounds are ruined, it is obvious that the fish populations will decrease. In general, the native populations will decrease due to the explosion of the zebra mussel population in the Great Lakes.*

7. The grasshopper (called a locust in many areas of the world) can cause serious damage to plants. Explain what impact an explosion of the grasshopper population would have on the organisms living in a grassland area.

*If the population of grasshoppers explodes, they will eat much of the grass and other leafy plants. Those organisms which feed on these same plants will find their food supply reduced or depleted altogether. They will probably starve or be forced to move to an area that has not been devastated by the grasshoppers. Those organisms that eat grasshoppers will have a much increased food supply and so their populations can increase. Other grasshopper-eating organisms might also move into the area.*

#### Section 4: Activity 3

1. A lumber company clear-cuts a mountainside forest. Explain what will happen to

- a. the community of plants and animals in the clear-cut area

*The community of plants will change. Some species will take advantage of the loss of trees and their populations will increase. Some species which were dependent on the old forest will be virtually eliminated. Most of the animals in the original forest will have to move to neighbouring forests since all of the animals in the forest depend on it for food, shelter, and water.*

- b. the neighbouring community of plants and animals in the remaining forest

*Most of the animals will move into the neighbouring forest from the clear-cut area. Therefore, the populations of animals will initially increase. This will cause the population of plants, which are the food supply of the animals, to decrease. The net result is that all populations in the neighboring forest will probably decrease due to increased competition for food.*

- c. the clear-cut area (in terms of regrowth)

*The forest will not grow back to its original form. The trees and plants that grow will tend to be the faster growing types. These types are not usually those valued as forest products. Some of the soil will probably erode from the clear-cut area which will make reforestation more difficult.*

2. Choose an organism (plant, animal, or insect) that has had a large impact on your own environment. Explain how your environment has been changed by that organism.

*These answers will vary. Probably the easiest organism to pick is the human. The effects of human activity on the environment are clearly visible in every area where people live. You can observe the effects of industry, farming, housing, and waste production.*

## Follow-up Activities

### Extra Help

1. Explain what would happen to the populations of rabbits, coyotes, and insects if the average amount of rainfall in a southern Alberta region were to increase from 30 cm to 50 cm.

*If the rainfall increases, plant growth should increase. This increase would allow the populations of plant-eating organisms to increase. Thus, the populations of predators who feed off those organisms should also increase. In general, the populations of rabbit, coyote, and insects would all increase if the amount of rainfall increased.*

2. Explain what would happen to the fish population if a lake were suddenly contaminated with oil.

*The population of fish would decrease. The layer of oil will prevent gases such as oxygen and carbon dioxide from entering and leaving the water. The oil could also add toxic chemicals to the water. All populations of organisms will decrease (if the spill is bad enough, the entire lake community can be destroyed).*

3. Explain what you think would happen if all the elk in Alberta suddenly died from a new disease.

*The populations of the predators of elk would end up decreasing. The populations of other first order consumers may also decrease, since the predators would have to focus on animals other than elk. The populations of plants that elk feed on would probably increase. Other animals that feed on the same plants would increase because of the decreased competition for food.*

### Enrichment

Do one of the following questions.

1. Write a short paragraph discussing the following statement.

Lack of education, personal and corporate greed, and misinformation presented by powerful individuals and groups require that management of world resources be taken from the hands of individuals, corporations, and governments. A worldwide scientific group must be in charge of all world resources in order to save the planet Earth.



After your discussion of the pros and cons of the statement, propose your own strategy to keep or to improve the present state of health of planet Earth.

*This is a question which can provoke a variety of answers. Removing the resources from the present controllers would be difficult. Also, it is reasonable to assume that while a scientific group might have the best interests of humanity in mind for some period of time, the group could be corrupted at any time. Most companies and governments start out with the good of people in mind, but corruption and greed often infiltrate these companies and governments. As environmental problems become matters of survival, the earth's population may learn to work together to solve the problems. Your own strategy to maintain the earth should be read by another individual who could give you a critique of your ideas.*

2. Seals eat fish. A common argument from fishermen is that if the seal population increases, the fish population decreases. Therefore, the hunting of seals should be encouraged in order to decrease the seal population. The fish population would then increase. Explain what you think is right and wrong with this argument.

*Many individuals think that if the seal population decreases, fish populations will increase. The problem of reduced fish populations is not linked to just one predator. The fish populations are determined by many other factors such as food supply, other predators, disease, suitability of spawning grounds, and overfishing by humans. So reducing the number of seals doesn't necessarily mean more fish for the fishermen.*

## Key to the Assignment Booklet

### Section 1 Assignment (25 marks)

- (10 marks) 1. The biosphere varies in thickness at different places on the earth. Select five different places where life exists on Earth and explain why the biosphere is as thick or thin as it is at each particular place.

*The student's answers will vary. Here are some examples of possible answers.*

- *Polar ice fields – 0 cm to 10 cm; the biosphere is very thin because of the low temperature, lack of soil, and short growing season.*
- *Desert – 10 cm to 10 m; the biosphere is very thin because of the lack of rain, temperature extremes, poor soil, etc. The 10 m maximum could be for the tallest cactus. A much lower range is acceptable.*
- *Oceans – 180 m in coastal zones and regions of upwelling; the thickness can be less in open ocean, which is much like desert. Sunlight can only penetrate to a depth of 180 m, therefore most life occurs in this layer. There is life at many other depths, but it is very limited.*
- *Rain forest – 100 m; the amount of rainfall, sunshine, and the warm climate all help to produce a very thick layer of life.*
- *Prairie grassland – 1 m to 3 m; the amount of rainfall, sunshine, and lack of trees keeps the layer quite thin.*

- (2 marks) 2. Life in the biosphere depends on a number of essential things in order to survive. List four of the most important life-supporting components of the biosphere.

*Answers may vary. Possible answers include food, air, water, proper temperature, and sunlight.*

- (3 marks) 3. Explain the effects of ultraviolet light on your skin.

*Longer wavelengths of ultraviolet light cause tanning of the skin. Shorter wavelengths cause the skin to burn. Prolonged exposure to ultraviolet light can also lead to skin cancer.*

- (3 marks) 4. How does the atmosphere protect living organisms from the harmful ultraviolet light that the sun emits?

*Oxygen and ozone in the upper levels of the atmosphere absorb ultraviolet light.*

- (4 marks) 5. While travelling in the high arctic in the summertime, a student noticed a small, circular patch where the vegetation grew much higher than elsewhere. She investigated and found the bones of a musk ox in the circular patch. Explain why the vegetation would grow so much better in that area.

*A musk ox died in that place. The decay of the animal released nutrients that are necessary for plant growth. The plants in the circular patch then grew much better because they had more available nutrients.*

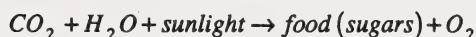
- (3 marks) 6. A local newspaper stated that the biosphere must be about 10 km thick, since life is found 5 km below the surface of the ocean and as high as 5 km into the atmosphere. Explain why this statement is incorrect.

*While life is found at depths of over 5 km in the ocean and as high as 5 km in the atmosphere, these are the limits of the biosphere. Only a very tiny fraction of life is found at these extremes. Most life is found in a very thin layer on the earth's surface, at depths above 180 m in water and as high as 100 m above land.*

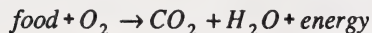
## Section 2 Assignment (25 marks)

- (4 marks) 1. Compare the processes of photosynthesis and respiration. Briefly explain the components required and the products created by each process.

*Photosynthesis:*



*Respiration:*

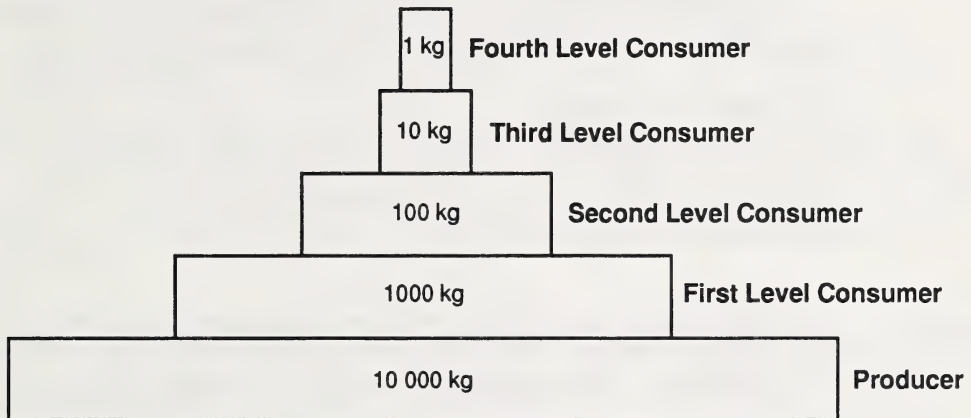


- (2 marks) 2. Explain why the sun's direct energy is not recycled.

*The energy from the sun is stored in sugars through photosynthesis. This energy is released as infrared heat in respiration and is lost since no organisms can harness infrared radiation.*



- (5 marks) 3. Construct a food pyramid that includes the levels from producer to fourth level consumer. Use a producer base of 10 000 kg, and then give the mass for each successive consumer level. Explain what happens to the energy as you move from one level to the next.



*The energy is lost as heat as the food is transferred from one level to the next. The student should try to explain that each consumer level only stores about 10 percent of the energy available from the level below it.*

- (3 marks) 4. Explain the difference between a food web and a food pyramid. Explain which is a better description of the energy transfer between organisms.

*A food pyramid describes the transfer of energy from one level to another. A food web describes the transfer of energy from one organism to another. The food web is a better description because there are organisms that belong to more than one feeding level in the food pyramid.*

- (8 marks) 5. A scientific group has decided to start a colony on the moon. You have been selected to plan for the survival of the colony that is to have 100 men, women, and children. Since space transport is very expensive, you must make the colony totally self-sufficient. Explain how the colony could obtain the essentials for maintaining human life. Your answer should discuss the four main needs of human life.

*This answer should address the four main needs of human life.*

- *Air*
  - *A sealed environment is needed to keep in the air.*
  - *Plants can be used to recycle oxygen.*

- *Water*
  - *All water must be recycled (Plants might be the best filter.).*
- *Food*
  - *The food must be grown within the sealed environment. The majority of the food must come from producers, since the colony probably could not afford the first level consumer as a source of food.*
- *Temperature control (heat)*
  - *Solar energy would be harnessed, both as a source of heat and light for photosynthesis. The site must be selected to ensure sufficient solar energy.*

*Other issues can be discussed.*

- (3 marks) 6. Some people argue that the world is becoming overpopulated because the earth cannot provide enough food for everyone. Other people argue that if people were to stick to a vegetarian diet, there would be ample food for everyone. Discuss these statements. Be sure to include your knowledge of the rule of ten. Also include the kinds of foods that first order consumers usually eat, as compared to what people eat.

*Since first order consumers lose 90% of the energy that they consume, it might be reasonable to assume that if people ate consumers only, and not first or second order consumers (such as beef and fish), that far more people could be fed from a limited plant food supply.*

### Section 3 Assignment (25 marks)

- (8 marks) 1. List the organisms that are most responsible for the recycling of each of the following essential substances.
- a. oxygen  
*organisms that produce food by photosynthesis*
  - b. carbon  
*plants and animals*
  - c. water  
*plants and animals*
  - d. nitrogen  
*plants, nitrogen-fixing bacteria, and blue-green algae*

- (2 marks) 2. Explain how biodegradable wastes are recycled in nature.

*Biodegradable wastes are ultimately broken down by the decomposers (specifically fungi and bacteria). The components of the waste are then available for plants to use for growth.*

- (4 marks) 3. Plants cannot use nitrogen directly from the air. Explain how plants and animals obtain the nitrogen they need.

*Nitrogen is usable by plants only when it is fixed into nitrates. Nitrogen-fixing bacteria and blue-green algae are the only living organisms that are able to fix nitrogen. Plant-eating animals obtain the nitrogen they need from the bodies of the plants they eat. Carnivorous animals obtain the nitrogen they need from the bodies of the animals they eat. Nitrogen is also fixed by lightning.*

- (4 marks) 4. Humans are responsible for producing nonbiodegradable wastes. Explain what would happen to life on Earth if nonbiodegradable wastes were produced and not recycled.

*There should be discussion of the effects of hazardous nonbiodegradable wastes on organisms and on the environment. Cumulative effects tend to be the most dangerous since they often do not pose a danger until it is too late. The obvious theme is that life cannot continue if nonbiodegradable wastes are not recycled.*

- (4 marks) 5. The plastics industry feels that it is the target of unfair attacks by environmentalists. The industry argues that while plastics are essentially nonbiodegradable, they are harmless to living organisms since they produce no toxic substances. Do you agree with the opinion of the plastic industry? Explain why or why not?

- *Agree*
  - *Other than unsightly litter, plastics should not pose a hazard to the environment.*
  - *Plastics are generally easy to recycle.*
- *Disagree*
  - *Plastics can harm large populations because they last so long. For example, plastic driftnets that are lost at sea float until they become filled with fish. They then sink until the mass of fish rots. Then the driftnets rise up to the surface again until they fill with fish and sink, repeating the death cycle until the plastic floats decompose. Other examples of this are plastic lobster traps and plastic can holders from six packs.*
  - *Large amounts of plastic garbage would degrade the esthetic quality of the environment.*



- (3 marks) 6. Nature provides fresh water to living organisms by evaporating water into the atmosphere and sending virtually pure water back to the surface as rain or snow. Over the past 100 years the rain has become less and less pure. What has happened to cause this change? What effect does this have on life?

*Human activity has produced large amounts of airborne pollutants. Most of these have come from industrial smokestacks and from automobile exhaust. These pollutants that dissolve in rain droplets tend to form acidic, dirty rain. Acid rain has had devastating effects on basically all life forms, especially those in lakes and forests. Technology will have to move ahead to solve this major problem which affects the entire planet.*

#### Section 4 Assignment (25 marks)

- (3 marks) 1. You may have heard a fisherman say that “the lake was full of fish.” Explain why this statement could never be true by discussing the physical factors that limit populations.

*Students should discuss factors such as food, oxygen, and wastes. The fish population may reach a high level, but eventually must stabilize due to the limiting physical factors.*

- (4 marks) 2. List as many physical factors as you can which limit the salmon population in the Pacific Ocean.

*Lists of physical factors should include the following:*

- *food supply*
- *water temperature*
- *pollution of water*
- *destruction of spawning grounds*

- (4 marks) 3. Explain the difference between a biosphere and an ecosystem.

*The biosphere is a “larger picture” since it is everywhere that life exists. The ecosystem is a small section of the biosphere (ie. an ecosystem is a subset of a biosphere). The term ecosystem is used when the interaction of living and nonliving things is discussed.*

- (7 marks) 4. The Swedish forest industry is responsible for the thinning of trees. This same thinning process is often used by Alberta gardeners. More seeds are planted so that there are no empty spaces in the garden row when seeds fail to germinate. Wherever there are too many plants in a row, the weaker plants are pulled out so that the garden space is maximized for the remaining plants. Explain why thinning is used in Swedish forests but is not practised in Alberta forests.

**Hint:** Think about the amount of labour it takes to thin a forest, the population densities of Sweden and Canada, access to the forests, climate, type of government, and the market value of the forest products.

You may use other reference materials to help you answer the question.

*Thinning allows each tree to have enough sunlight, water, and soil nutrients to maximize growth. Also, weaker trees, unwanted species, and diseased trees can be removed, making for a healthier, faster growing forest. This practice can be used in Sweden because individuals have control over small sections of forest and this labour intensive activity can be carried out by individuals. In Alberta the forests are largely owned by the provincial government and logging is carried out by corporations, not individuals. Since the corporations do not profit by taking care of the forest, they do not make an effort to maximize forest production over a long period of time.*

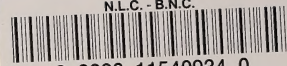
- (7 marks) 5. There is a fungus which causes a blight on potato plants. Recently, the potato crops in Eastern Canada suffered an outbreak of the potato blight. Describe the impact that this disease could have on the potato plant population, and, in the future, the effects on the potato farmers, consumers, and foreign markets.

*The potato population may or may not decrease. If the farmers continue to plant potatoes, the population will not change much. They may have to reduce the number of potatoes that they plant because they cannot sell the product. The impact on the farmers might be severe if they cannot sell the product or if the product is severely damaged by the blight. Consumers might have to purchase poor quality potato products or may have to pay more for imported potatoes. The foreign markets may ban imports of potato products, causing an increase in the price of potatoes in that foreign market.*









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